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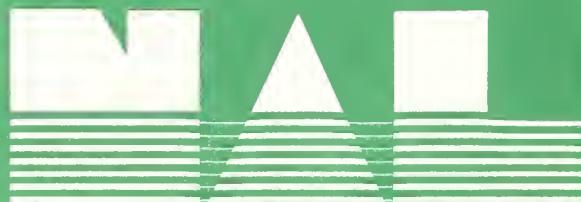
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# GRASSHOPPER Survey

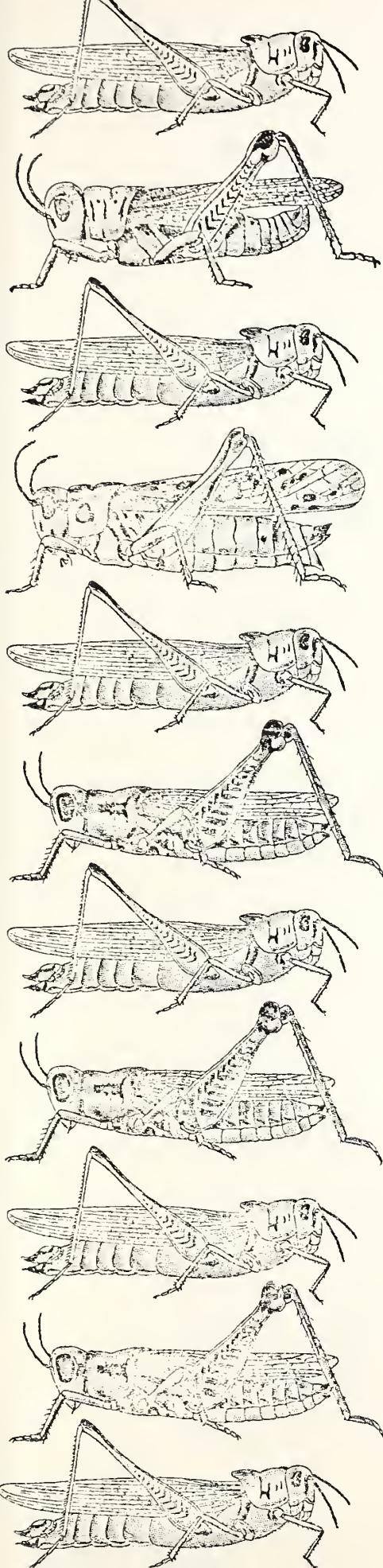
SPECIES  
FIELD  
GUIDE



**United States  
Department of  
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# GRASSHOPPER SURVEY

U.S.D.A., NAL  
AUG 03 2005  
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SPECIES  
FIELD GUIDE

UNITED STATES DEPARTMENT OF AGRICULTURE  
ANIMAL AND PLANT HEALTH INSPECTION SERVICE  
Plant Protection and Quarantine Programs



## FOREWORD

Grasshopper survey is an important function of the Animal and Plant Health Inspection Service, Plant Protection. Data obtained is essential to Federal, State, and county officials, industry, and growers to make plans and timely preparations for situations that might otherwise develop into costly emergencies. Applications of uniform survey methods and proper appraisals of population are essential. Knowledge of grasshopper species, habits, habitat, and behavior are significant factors in developing meaningful conclusions.

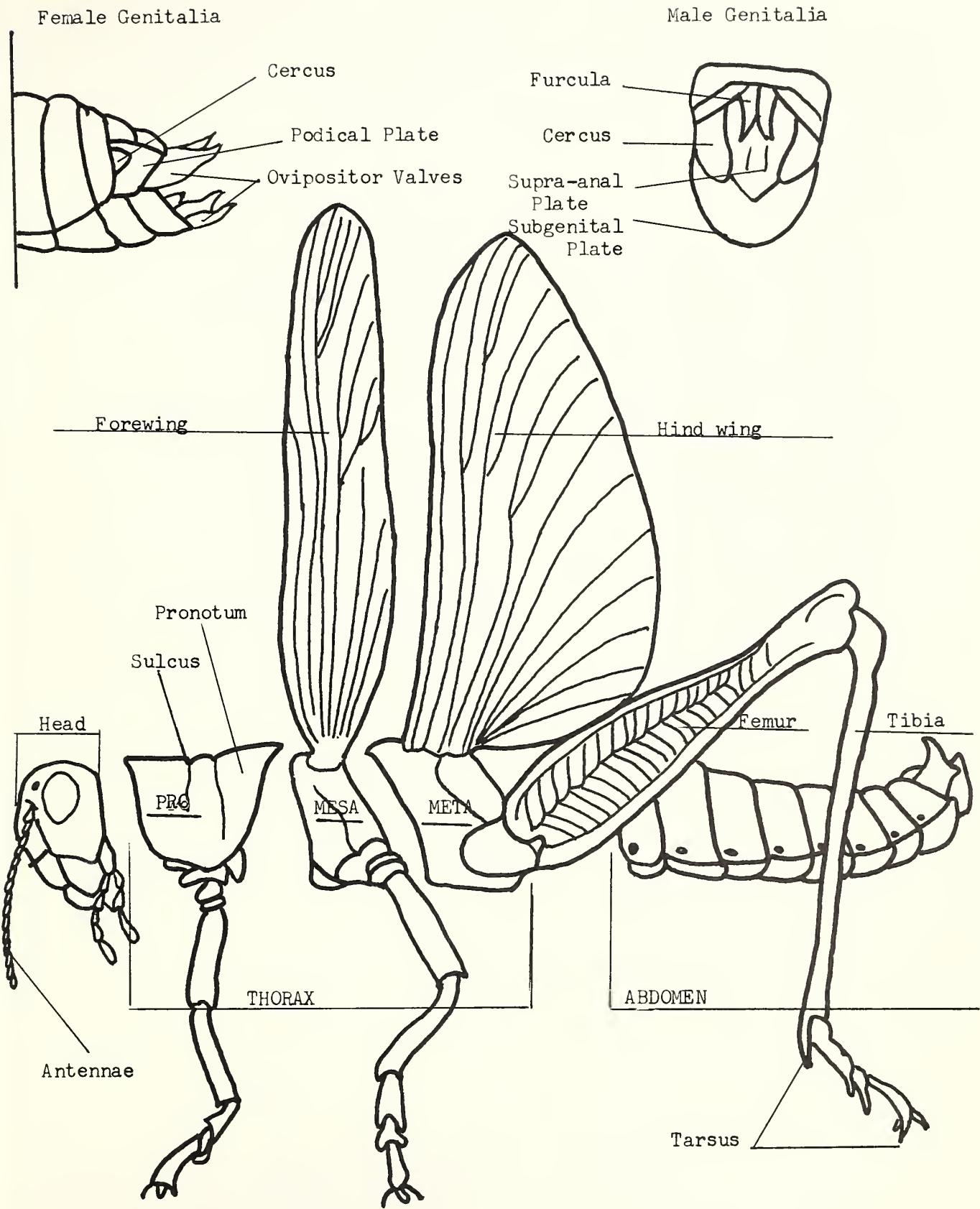
The mechanics and field techniques of grasshopper survey are well defined, easily understood, and simple to emulate. To the novice, the most frustrating part of grasshopper survey is the great number of species involved. This need not be the case. Each state has documented records of from 125 to 250 different species within its boundaries. This coupled with the scientific names can be awesome. However, seldom will it be necessary to be able to identify more than fifteen species in a state in order to identify 95% of the population. Actually, 'hoppers have to be present in numbers to be of economic importance; therefore, the surveyor need only concern himself with those so encountered. The complex of 'hoppers present in any given area will remain relatively constant over the years. Numerical predominance will often fluctuate between species of a complex from year to year.

Some grasshoppers that were formerly very destructive have now virtually disappeared. This has taken place over a long period of time and they have largely been replaced by other species. Also some species are actually beneficial -- feeding almost exclusively on undesirable plants.

The surveyor should become familiar with and learn to recognize the predominant species within his assigned area. The occasional "unfamiliar" species encountered can be collected and taken to the supervisor for identification. As time of field experience increases, they will find identification less troublesome and instill self-confidence.

The material presented herein includes brief descriptions of the grasshoppers most frequently encountered by field personnel and is intended to assist the surveyor in all phases of grasshopper survey. It includes the scientific name, author, common name, if available, and the readily identifiable characteristics. The characteristics listed are not necessarily taxonomic and should be used on live or recently killed 'hoppers. The outstanding characteristics are underlined. Some color variations will be noted within the species. It is not intended as a key, but a simplified guide that will be accurate ninety per cent of the time. It is conceivable that situations will arise that are not covered. In such cases the surveyor should contact his supervisor for assistance or direction to proper authorities.

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## Potential Ecological and Economic Range

Listed below are the species most frequently found west of the Ohio and Mississippi Rivers. They are listed by State and species with a rating from 0 to 4. Ratings are as follows:

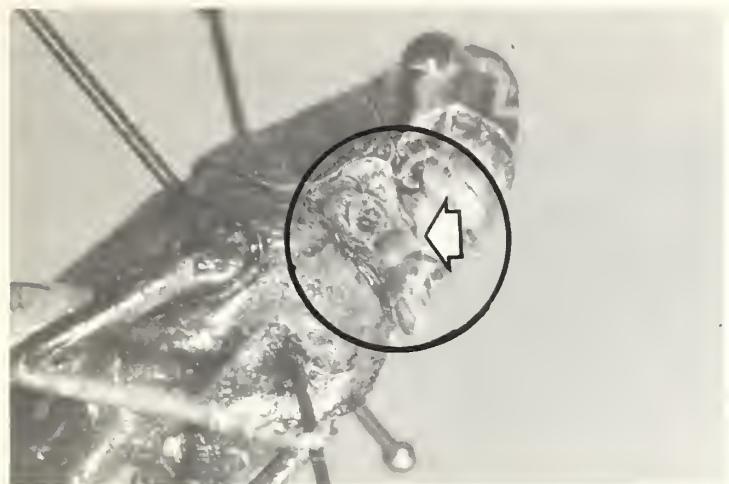
- 0 - Never or Exotic
- 1 - Rare
- 2 - Occasionally - Never economic
- 3 - Common - Capable of damage
- 4 - Frequent - Often causing damage

To use the chart effectively, the surveyor should locate the State of his assignment along the top and read down. Each time he encounters a 3 or 4, read to the left. This will identify the species. The beginner should familiarize himself with all the species with a 3 or 4 rating by referring to the description following the chart. As your knowledge, experience, and confidence grows, expand to include the 2 rating.

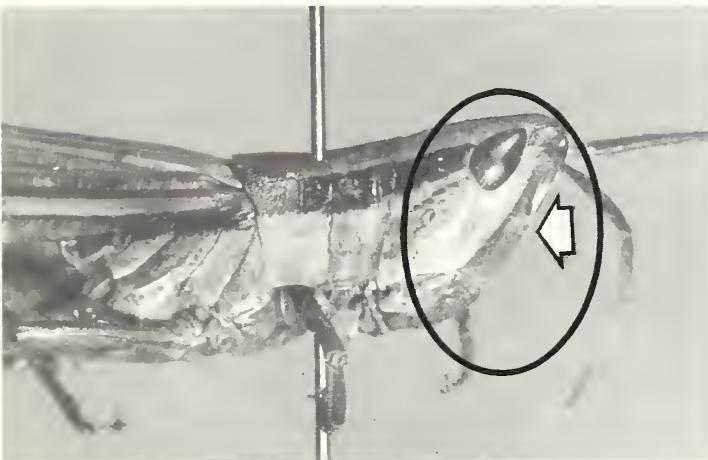
Species	Akz.	Ark.	Calif.	Colo.	Idaho.	Ill.	Iowa	Kansas	Mich.	Minn.	Mo.	Neb.	Nev.	N.Mex.	N.	Ohi-o.	Okla.	Ore.	Texas	Utah	Wash.	Wisc.	Wyo.	
<b>ACRIDINAE</b>																								
<i>Aeropedellus</i>	2	0	2	2	0	0	0	0	1	0	3	2	2	1	2	0	0	0	3	0	1	0	0	3
<i>clavatus</i>																								
<i>Ageneotettix</i>	4	1	2	4	3	2	1	2	4	2	3	3	4	4	3	3	4	0	4	3	4	1	2	4
<i>deorum</i>																								
<i>Amphitornus</i>	4	1	4	4	4	1	0	1	3	0	1	0	4	4	4	4	0	4	4	3	3	2	0	4
<i>coloradus</i>																								
<i>Aulocara</i>	4	1	4	4	1	1	1	4	0	1	1	4	4	4	4	4	0	4	4	4	4	3	1	4
<i>elliotti</i>																								
<i>Boopedon</i>	3	1	1	2	2	0	0	3	0	0	2	2	1	0	2	1	0	3	2	1	0	0	2	
<i>nubilum</i>																								

ACRIDINAE (Cont.)	Drepanoptera femoratum	Morseiella flaviventris	Philobostroma quadrimaculatum	Psoloessa delicatula	Aeoloplides turnbulli	Melanoplus angustipennis	Melanoplus bivittatus	Melanoplus bowditchi	Melanoplus cuneatus	Melanoplus devastator	Melanoplus differentialis	Melanoplus femurrubrum	Melanoplus foedus	Melanoplus gladstoni	Melanoplus infantilis	Melanoplus lakinus	
Ariz.	3	0	3	0	0	0	2	0	0	3	3	1	3	2	0	3	1
Calif.	3	0	2	1	1	0	0	0	0	0	2	0	0	0	1	2	0
Colo.	4	1	0	4	2	1	2	4	2	3	4	4	3	4	2	4	2
Idaho	4	0	2	3	2	1	0	1	2	0	1	3	2	2	2	1	3
Ill.	0	0	3	0	0	0	2	0	0	3	1	3	0	0	0	0	3
Iowa	0	0	3	0	0	0	2	0	0	3	1	3	0	0	0	0	3
Kansas	0	0	3	2	0	0	0	3	0	1	3	1	2	0	3	0	3
Michigan	0	0	3	1	1	0	0	0	0	0	2	0	0	0	1	2	0
Minnesota	0	0	3	1	1	0	0	0	0	0	2	0	0	0	1	2	0
Missouri	0	0	3	1	1	0	0	0	0	0	2	0	0	0	1	2	0
Mont.	0	0	3	1	1	0	0	0	0	0	2	0	0	0	1	2	0
Nebraska	0	0	3	1	1	0	0	0	0	0	2	0	0	0	1	2	0
Nev.	0	0	3	1	1	0	0	0	0	0	2	0	0	0	1	2	0
New Mexico	0	0	3	1	1	0	0	0	0	0	2	0	0	0	1	2	0
Oklahoma	0	0	3	1	1	0	0	0	0	0	2	0	0	0	1	2	0
Ore.	0	0	3	1	1	0	0	0	0	0	2	0	0	0	1	2	0
Texas	0	0	3	1	1	0	0	0	0	0	2	0	0	0	1	2	0
Utah	0	0	3	1	1	0	0	0	0	0	2	0	0	0	1	2	0
Wyoming	0	0	3	1	1	0	0	0	0	0	2	0	0	0	1	2	0

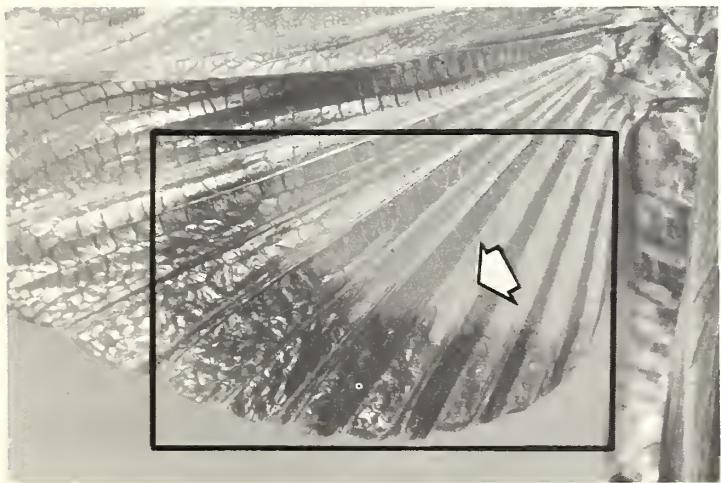




CRYTACANTHACRIDINAE  
**SPUR THROAT**



ACRIDINAE  
**SLANT FACE**



OEDIPODINAE  
**BAND WING**

REAR MARGIN OF PRONOTUM NEARLY  
ALWAYS PRODUCED TO A RIGHT ANGLE



## ACRIDINAE\*--- Slant Face

Face decidedly oblique. Prosternal spine absent. Wings never colored; usually transparent. General body conformation is long and slender. Antennae variable. Pronotum usually smooth, median carinae not crested or cut by more than one sulcus. Tegmina and wings frequently not fully developed; usually short. Caudal femora generally slender. Males stridulate only at rest. General color widely variable. Often similar to Oedipodinae except bodies are longer and more slender with a cone shaped head. Usually found in marshes, prairie grass or meadows.

Aeropedellus clavatus (Thomas)

Size small, moderately compressed. General color brown, sometimes marked with or replaced by green. Head horizontal. Face moderately oblique. Antennae strongly clubbed (widened and flattened) at apices. Tegmina shorter than abdomen. Caudal femora reaching at least to the tip of abdomen. Caudal tibiae buff or brown. Found in dry grassy uplands of the western plains.

Ageneotettix deorum (Scudder) "White Whiskers"

Size small. Form short and stout. General color dull brown above, pale yellow beneath. Antennae ashen white, longer than head and pronotum. Tegmina grayish brown or brown marked with dark spots in a row in the median area, reaching about the tip of the abdomen. Knees black. Caudal tibiae bright orange to red with pale proximal annulus. Very common grassland 'hopper capable of inflicting heavy damage to rangeland grasses.

Amphitornus coloradus (Thomas)

Size small to medium. Form slender. General color yellowish brown; marked with a median longitudinal yellow stripe extending from vertex nearly to tips of tegmina, bounded on each side by broad dark stripe and yellowish postocular. Antennae very feebly flattened and about as long as head and pronotum. Tegmina exceeding tip of abdomen. Caudal femora exceeding tip of abdomen. Knees black. Caudal tibiae always blue. Common grassland species.

\*Acridinae is used here in a broad sense because in most recent classifications the "slant-faced" grasshoppers are assigned to several subfamilies, the majority to the Gomphocerinae.

Aulocara ellotti (Thomas)

Size small to medium. General color dull reddish brown, often marked with gray above, yellowish brown beneath. Head large. Pronotum compressed medially, disk marked with two diagonal stripes forming an "X". Tegmina reaching tip of abdomen. Caudal femora of females reaching to tip of abdomen, (males exceeding) and with two dark bars. Posterior margin of eighth abdominal sternum of female weakly bisimuate, the lateral processes represented by the evenly convex lateral margins of the sternum. Median processes low and blunt, the sinuses shallow. Caudal tibiae blue, claws of hind tibiae nearly equal. Tarsi not orange. Common in grasslands, frequently reaching very high populations.

Boopedon nubilum (Say) "Boopie"

Size large and robust. Male black, female usually green and brown with purplish hind tibiae sometimes entirely black. Female head conspicuously large. Male antennae longer than head and pronotum; wing bluish, often clouded at tip. Tegmina of female usually green or brown, shorter than abdomen. Found most frequently in coarse grass rangeland areas.

Chorthippus curtipennis (Harris)

Size small. General color greenish brown above, yellowish beneath. Head nearly horizontal, face moderately oblique, vertex triangular. Pronotum with a narrow dark postocular band across the upper portion. Tegmina of variable length with male generally about the length of abdomen and females considerably shorter; nearly immaculate. Caudal femora slender and immaculate with dark apical annulus. Common in moist meadows and pastures.

Cordillacris sp.

Size small. Form slender. General color buff to light brown with pale dorsal area on head and pronotum frequently divided by a thin brown stripe; dark brown postocular stripe extends over pronotum. Head nearly horizontal, face very oblique. Tegmina fully developed reaching at least tip of abdomen and marked with blotches of fine maculations. Caudal femora exceeding tip of abdomen. Caudal tibiae buff, brown, or orange - never blue as in A. coloradus. Prefers grassy areas on sandy soil.

Dichromorpha viridis (Scudder)

Size small to medium, moderately robust. General color green or brown. Head horizontal. Face acutely oblique. Fastigium with no median ridge. Tegmina abbreviate, ovate-lanceolate, inner margin overlapping, usually one-half to three-fourths as long as abdomen, relatively stout and immaculate. Caudal tibiae buff or brown tinged with green. An eastern species found in pastures, meadows, and roadside grasses.

Drepanopterna femoratum (Scudder)

Quite often confused with Aulocara. The posterior margin of the eighth abdominal sternum of female bisinuate. The median and lateral processes strong, separated by deep sinuses. Claws of hind tibiae decidedly unequal. Caudal tibiae blue. Tarsi orange. Generally colors and markings more distinct than Aulocara. Widely distributed rangeland species, often causing economic damage.

Encoptolophus sp.

Size small to medium. General color light to blackish brown. Head swollen. Pronotum with median carinae high. Tegmina with three dark transverse bands on lighter background. Hind wings transparent with fuscous apices. Caudal femora with darker bars. Widespread in midwest. Found in wide variety of habitats, usually in open sparse vegetation.

Eritettix simplex (Scudder)

Size small. General color yellowish brown to brown, often tinged with green and red. Head horizontal. Face very oblique. Antennae clubbed (flattened) at apices. Pronotum with two brown stripes extending across the length of pronotum starting at the vertex or just behind the eyes. Tegmina exceeding the tip of abdomen with overlapping inner margin, frequently darker. Femora exceeding tip of abdomen reddish or greenish brown. Tibiae buff. Common early season species in the grasslands of the mid-west and great plains.

Mermiria bivittatus maculipennis (Bruner)

Size large. General color bright yellowish brown or yellowish or greenish marked with brown. A broad postocular band extending across lateral lobes of pronotum. Head nearly horizontal, very slightly ascending. Face extremely oblique. Antennae reddish and ensiform. Pronotum long and moderately tectate. Tegmina reaching or exceeding tip of abdomen. Caudal femora long and slender. Hind tibia reddish. Hind leg easily detached. Found in short dry grassy areas.

Morseiella flaviventris (Bruner) "Whoopie"

Size large. Body yellowish to brown, yellowish beneath, hind femora yellow with blackish marks. Form robust. Head large and inflated. Face nearly vertical. Pronotum moderately tectate with median carinae distinct. Wings abbreviate. Tibiae bright red with black and yellow rings at base. Serious range species of the southwest.

Orphulella pelidna (Burmeister)

Size small. General color yellowish brown to brown with green markings. Head horizontal. Face oblique. Tegmina narrow, exceeding abdomen, marked with row of blotches in median area. Femora reddish brown with weak fuscous bars. Tibiae greenish or brownish with pale annulus. Prefers moist tall grass.

Phlibostroma quadrimaculatum (Thomas) "P. quad"

Size small. Form robust. General color greenish or brownish above, yellowish brown beneath. Head large. Face nearly vertical. Postocular stripe extending only to pronotum. Tegmina variable in length, brown or greenish with four irregular triangular spots, their apices toward the costa. Caudal femora exceeding tip of abdomen. Caudal tibiae buff or orange. Common and often destructive in pastures and range-land of the plains states.

Psoloessa delicatula (Scudder)

Size small. General color buff to wood brown. Face nearly vertical. Vertex well marked, median carinae only faintly raised. Postocular stripe distinct and extending over pronotum. Pronotum constricted

medially; median carinae distinct. Tegmina exceeding tip of abdomen, immaculate except for row of sub-quadrata markings in median area. Caudal femora with traces of bars laterally. Caudal tibiae pale buff, orange or brown. Prefers short grasses in areas of thin poor soil. Over-winters as partially grown nymph. Found in northern great plains.

Syrbula admirabilis (Uhler)

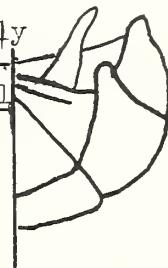
Size large; males considerably smaller. Form slender. General color - males brown with pale markings; females green and brown. Tegmina extending to tip of abdomen; marked with numerous (5-6) triangular blotches along medial edge. Caudal femora yellowish with two to three bars on outer surface. Knees black. Caudal tibiae pale with 15-24 spines in outer row. Prefers dry areas and grasslands.

CYRTACANTHACRIDINAE - Spur Throat. This name is used in a broad sense. Recent classifications use Catantopinae for some.

A prosternal spine is always present between the front pair of legs. Size widely variable. Antennae slender and longer than front femora. Lateral foveolae are either indistinct or absent. Pronotum usually flat dorsally and free of tubercles and prominent wrinkles. Median carinae is low and entire. The tegmina are usually well developed, but short winged forms are present. The inner wings are never brightly colored or banded, usually transparent. Males rarely stridulate and then only when at rest.

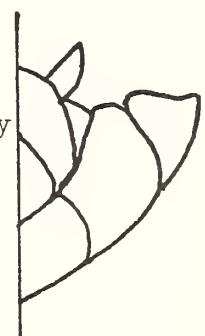
*Aeoloplides turnbulli* (Thomas) "Thistle 'hopper'"

Size small to medium. Form short and stout, prosternal spine long and conical with apex moderately pointed. Antennae orange. Wings shorter than abdomen. Male subgenital plate small with an apical tubercle. Hind femora with three dark bands on outer surface. Hind tibia pale blue or bluish green with a pale postproximal band. Male cerci slender and tapering. Male furcula minute. Associated with weeds, particularly Russian thistle and kochia.



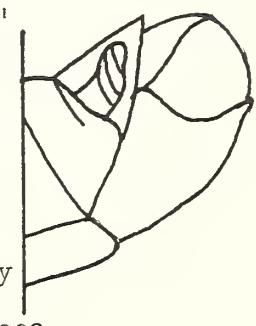
*Campylacantha olivacea* (Scudder)

Size small to medium. General color olivaceous green and covered with fine pile. Vertex of head marked with darker medium green stripe, frequently marked with a paler median stripe. Tegmina green and about one-half the length of the abdomen. Supra-anal plate narrow, triangular with sides nearly straight. Apex acute but bluntly pointed. Furcula minute, rounded adjacent lobes. Cerci straight, slender, tapering to rounded tip. Subgenital plate bluntly angulate at apex with a small apical tubercle. Associated with weedy grasslands.



*Dendrotettix quercus* (Packard) "Oak grasshopper"

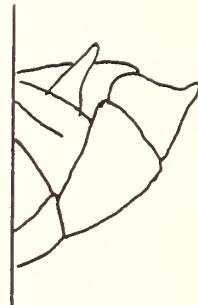
Size medium. Form robust. General color yellow, greenish yellow or grayish brown. Pronotum brown marked with yellow and black; median carinae distinct and entire. Wings usually abbreviate although occasionally fully developed; inner margin normally separated. Supra-anal plate long and triangular. Furcula minute, triangular and widely separated. Cerci small, short and stout, with apices bluntly rounded, the whole twisted nearly 90°



Sub-genital plate black. Commonly found in grass-lands associated with oak groves. Found in Great Lakes States.

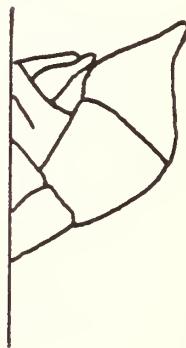
Hesperotettix speciosus (Scudder)

Size large for genus. General color grass green flushed with pink. Pronotum tectiform, with a pinkish median line, distinctly rugous. Tegmina greenish or yellowish green two-thirds length of abdomen. Cerci slender, slightly tapering, in-curved, about as long as supra-anal plate. Found in dry weedy rangeland.



Hesperotettix viridis (Scudder)

Size small to medium. General color yellowish green. Pronotum not rugous or tectate, marked with whitish medio-longitudinal stripe bordered on both sides with a black stripe. Tegmina fully developed, greenish color marked with two whitish longitudinal stripes. Hind femora with pink areas marked with black, ventral surfaces greenish. Hind tibia bluish green. Cerci slender, shorter than supra-anal plate. Found in dry weedy range-land.



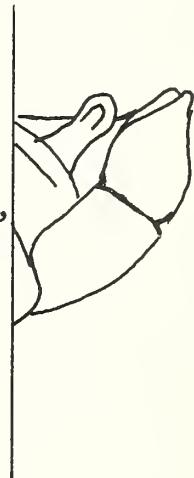
Melanoplus (Cyrtacanthacridinae)

Size small to large. General color usually dull. Head moderately prominent. Face nearly vertical. Dark post-ocular stripes present. Antennae slender and of variable length. Prosternal spine always present. Tegmina variable from acutely abbreviated pads to exceeding tip of abdomen. Wings always colorless. Ovipositor of females fully exserted. Caudal femora long and slender and exceeding the tip of the abdomen. Knees darkened. Caudal tibiae quite variable.

All melanopli have the above characteristics. Those listed below expand on these or unique characters thereby identifying the species.

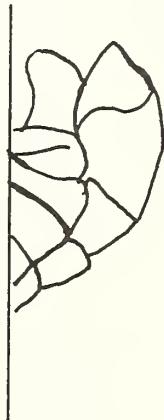
Melanoplus angustipennis (Dodge)

Size medium. General color dusky grayish brown. Prosternal spine short and blunt. Inner surface of femora yellowish-orange. Supra-anal plate acutely constricted in apical fourth forming a narrow blunt projection. Furcula slender, tapering, diverging, and about one-third length of supra-anal plate. Cerci moderately spatulate and curving around the supra-anal plate to the apical projection. Apical one-third concave forming ridge along edge. Sub-genital with apex faintly elevated and notched. Prefers grassy areas on poor or sandy soil.



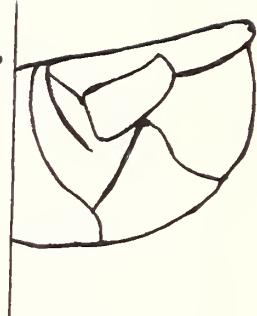
Melanoplus bivittatus (Say) "Two striped"

Size medium to large. General color from light green to dark brown above, pale yellow beneath. Tegmina reaching or exceeding caudal femora. Two light colored stripes which extend from near the eyes almost to the apices of the tegmina. Hind tibiae bluish black, pink, or dull yellow to brown. Male furcula short, acutely swollen, triangular and widely separated. Male cerci with large projection above and a small angulation below. Well known and widely distributed in the United States. Capable of tremendous populations and crop damage. Also recorded as migratory.

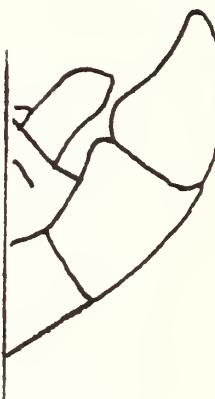


Melanoplus borealis (Fieber)

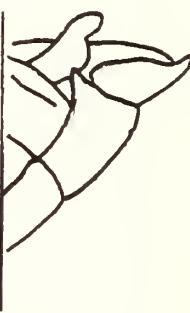
Size medium. Front wings with a faint median line or dark and medium spots. Hind tibiae bluish green, reddish or yellowish brown. Subgenital plate wider than high viewed from rear; broadly and bluntly produced, usually margined with black. Male furcula stout touching at base, outer margins nearly parallel, inner margins separating in acute angle. Male cerci moderately slender except considerably expanded at base; shorter than supra-anal plate. Found in swampy or marshy grasslands of northern latitudes or higher elevations.

Melanoplus brunneri (Scudder)

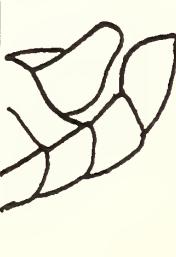
Size medium. Color similar to sanguinipes. Mesosternum with medium tubercle. Apex of subgenital plate produced, truncate, and usually notched. Furcula usually large with arms joined for distance at base about one-half the length of supra-anal plate. Male cerci short and flat but twice as long as broad; shorter than supra-anal plate. Found in northern climates or higher elevations and associated with woodlands.

Melanoplus confusus (Scudder)

Size small. Color dark or reddish brown. Leg is length of abdomen or longer. Hind femora red below bars on outer face. Tibia greenish blue. Supra-anal plate triangular with apical third distinctly raised. Male furcula well developed but small; the arms cylindrical and slightly bowed about one-fourth the length of supra-anal plate. Male cerci with a small ventral lobe. Apical one-half turned inward and conspicuously broadened. Subgenital plate small, narrow, and not elevated. Appears very early in the season. Found in native grasslands.

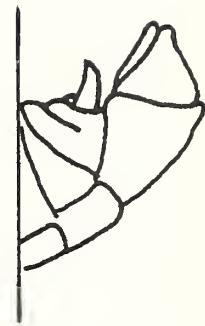
Melanoplus cuneatus (Scudder)

Size small to medium. General color brown above, pale beneath. Resembles Melanoplus occidentalis. Blue tibia. Usually bright orange inside femora. Three dark bands on upper surface of hind femora. Furcula reduced to blunt knobs. Subgenital plate nearly trapezoidal as seen from rear. Male cerci nearly minute; faintly triangular and toothlike. A southwestern range species.



Melanoplus dawsoni (Scudder)

Size small. General color dark brown above, dull yellow beneath. Yellow plural membranes give the impression of the abdomen being banded. Short wings. Tegmina flat, ovate-lanceolate, pointed pads slightly longer than pronotum. Supra-anal plate small, longer than broad, lateral margins, slightly elevated, apex moderately rounded. Furcula well developed, slender, tapering, about half the length of supra-anal plate. Cerci slightly bent and foliate; the bases expanded and apices bluntly rounded, nearly as long as the supra-anal plate. Found in sandy areas with light vegetative cover.

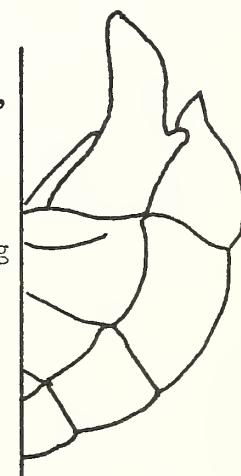


Melanoplus devastator (Scudder)

Very similar to M. sanguinipes except subgenital plate not as long or as strongly produced and notched. Swelling between middle legs either weak or absent. Found in California and adjoining areas of adjacent states.

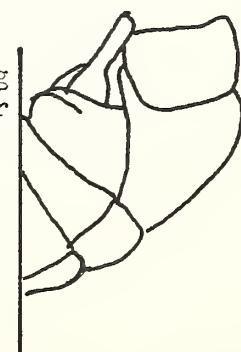
Melanoplus differentialis (Thomas) "Differential 'hopper"

Probably the most widely known of all the grass-hoppers. Size large. General color yellowish to yellowish brown. Tegmina olive yellow, immaculate, and exceeding the caudal femora. Caudal femora short and stout, yellowish brown marked with black chevrons on the disk. Supra-anal plate large and broadly angulate at apex. Furcula absent. Cerci large with heavy dorsal projection and a projecting angulation on the ventral margin with a rounded projection at the point of angulation. Slightly longer than supra-anal plate. Melanistic forms occur. General distribution of the United States and very destructive in cultivated areas.



Melanoplus femur-rubrum (De Geer) "Red Legged 'hopper"

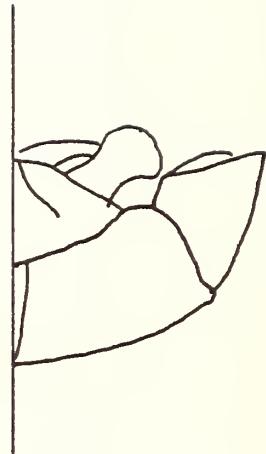
Size medium. General color greenish grayish to yellowish brown, yellow beneath. Tegmina exceeding caudal femora. Hind tibiae and inner face of femur usually red. Furcula large, slender or pointed, about half the length of supra-anal plate, with apical two-thirds well separated and lying outside the heavy ridge of the supra-anal plate. Cerci broad basally, tapering acutely to the center with the apical half nearly parallel to the evenly



rounded apices; slightly incurved and shorter than the supra-anal plate. Sub-genital plate broad and scoop shaped. Flies with characteristic quick fast flights of ten to thirty feet when disturbed. Distribution is general and found most extensively in legumes.

Melanoplus foedus (Scudder)

Very similar to Melanoplus packardii. (See Melanoplus packardii description). Exceptions usually accurate are: the dorsal stripes of foedus are broader and fused while packardii's are narrow, sharp and distinct. Found in areas associated with light or sandy soil. Occasional damaging to crops.



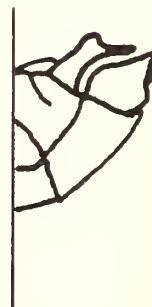
Melanoplus gladstoni (Scudder)

Size medium, stocky build. General color dark yellowish brown to blackish brown above, dull yellow beneath. Pronotum with disk darker and nearly flat. Tegmina yellowish brown to blackish brown with distinct maculation in median area; reaching or slightly surpassing caudal femora. Caudal femora yellowish brown with two oblique dark bars on disk. Caudal tibiae red. Supra-anal plate long and triangular with apex acute angulate. Cerci long and slightly spatulate; apices well rounded and curving slightly upward and inward and about as long as the supra-anal plate. The outer surface of apical half slightly concave. Subgenital plate small, weakly tapering and slightly elevated apically. Found in western grasslands.



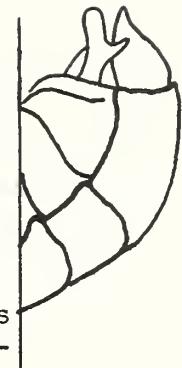
Melanoplus infantilis (Scudder)

Size small. General color dark gray, brown above, pale yellow beneath. Tegmina ash brown marked with light and dark spots reaching or exceeding hind femora. Supra-anal plate about as broad as long, triangular with convex side. Furcula minute triangular teeth. Cerci large, forked, bootshaped, with ventral arm much larger and heavier. Subgenital roughly triangular with a sharp elevation at apex, narrowly notched. Found in western grasslands.



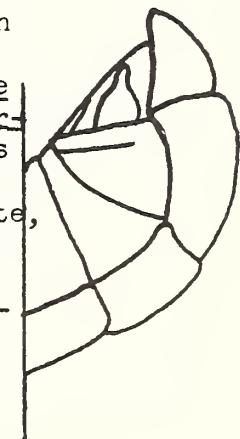
### Melanoplus keeleri (Dodge)

Size small to medium. General color grayish brown above, yellowish green below. Face bluish gray mottled with purplish brown. Tegmina brownish marked with a row of darker spots in median area; reaching or slightly exceeding caudal femora. Caudal femora long and slender, yellowish to yellowish brown, dorsal surface bifasciate. Ventral surface yellowish to yellowish orange. Knees black. Caudal tibiae dark pink to red. Supra-anal plate long and triangular with sides faintly convex, narrowing in apical one fourth with an obtusely angulate apex. Male furcula minute. Widely divergent, toothlike lying across the bases of the supra-anal plate. Male cerci with a prominent, long acute tooth projecting from the side but not bootshaped. Subgenital plate as broad as long with apex bluntly rounded, the apical margins slightly elevated. Generally distributed. Found primarily in grassy areas of dry slopes and barren pastures.



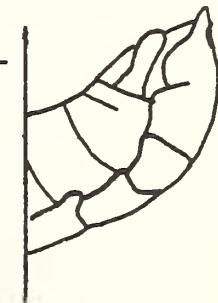
### Melanoplus lakinus (Scudder)

Size medium. General color brown to grayish brown above, yellowish beneath. Tegmina abbreviate, lanceolate, sharply pointed, with a definite angle between dorsal and middle area; inner margins overlapping. Caudal tibiae blue. Supra-anal plate as long as broad, triangular, with sides nearly straight and apex slightly rounded. Furcula minute, triangular, and well separated at bases. Cerci bulbous with apex extended and pointed, curving inward and upward. Subgenital plate short, tapering, with apex distinctly produced and elevated. Found in western grasslands.



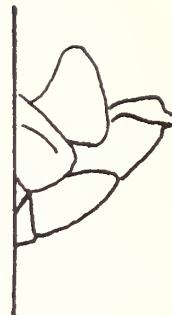
### Melanoplus marginatus (Scudder)

Size medium. General color brown to green; pale yellow beneath. Hind tibiae brownish to olive green. Short and long winged forms occur. Supra-anal plate long and pointed. Furcula minute and bluntly rounded. Cerci spatulate. Subgenital plate rectangular when viewed from rear; strongly pronounced tubercle. Common in grasslands and occasionally in crops. Found in California and adjacent areas of adjoining states.



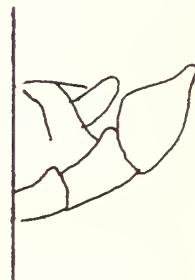
Melanoplus occidentalis (Thomas)

Size small to medium. General color reddish brown to dark brown above, mottled with blackish brown, light brown beneath. Tegmina dark brownish with slender broken yellow stripe; appears speckled, slightly tapering, profusely maculate, and reaching or slightly exceeding the tip of the abdomen. Supra-anal plate as broad as long, triangular with convex sides and pointed apex. Furcula minute, triangular and toothlike. Cerci short and broad, triangulate (almost equilateral), angles broadly rounded, the whole slightly incurved and upcurved. Subgenital plate scoop shaped with sub-apical conical tubercle. A western grassland grasshopper.



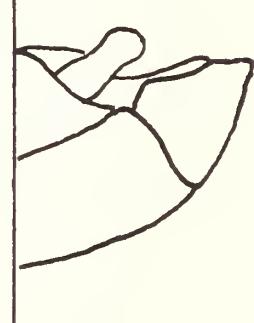
Melanoplus oregonensis (Thomas)

Size small. Wing short, about the length of the pronotum. Hind tibiae greenish or yellowish. Furcula large, considerably longer than last abdominal segment dorsally. Cerci flat throughout, tapering slightly towards apex. Found in grasslands of the pacific northwest and mountain states.



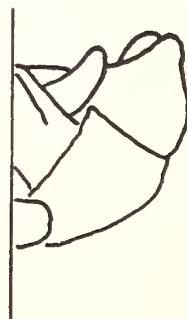
Melanoplus packardii (Scudder) "Packards 'hopper"

Size medium to large. Color brownish to gray, pale beneath head and pronotum, usually appearing striped. Tegmina grayish brown; longer than abdomen. Hind femora yellow to yellowish orange, two dark bars on dorsal and inner surfaces. Ventral surfaces usually orange. Hind tibiae greenish to red. Cerci slightly spatulate, narrowed at the middle, shorter at the anal plate, apices truncate. Found in plains states, often associated with crop damage.



Melanoplus sanguinipes (Fabricius) "Migratory 'hopper"

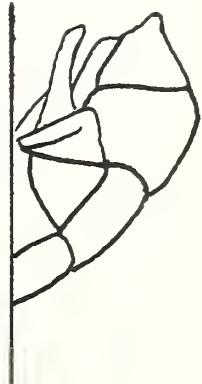
Size medium. Meso-sternum with strong median tubercle. General color grayish brown or reddish brown above, yellowish beneath. Tegmina grayish brown flecked with lighter along median area, considerably exceeding caudal femora. Well fitted for flight. Supra-anal plate broadly triangular with apex moderately pointed. Furcula small, less than one-third the length of the supra-anal plate, slender, pointed and moderately diverging. Cerci short and broad with dorsal and ventral margins nearly parallel with apices broadly rounded; slightly



incurved and upward. Subgenital plate strongly raised and notched. Well known species found all over North America. Strong flier and voracious feeder on all types of vegetation.

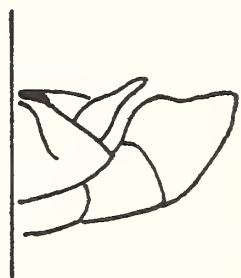
Melanoplus viridipes (Scudder)

Size medium. General color brownish above, yellowish beneath. Black stripe behind eye continued wide across metazona of pronotum; abdomen and hind femur conspicuously marked with black. Tegmina brownish above, the length of the pronotum, elliptical with round apices. Caudal tibia pale green. Supra-anal plate fairly flat, triangular with acutely angled apex. Furcula minute, toothlike, widely separated. Male cerci long and slender, tapering gradually in basal half with a down-curving point at tip. Subgenital plate longer than broad, slightly elevated with a small tubercle at middle. Prefers open grassy ravines and grassy woodlands.



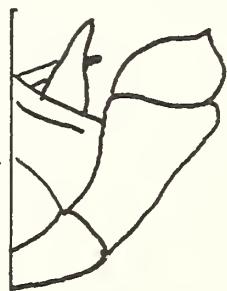
Oedaleonotus enigma (Scudder)

Medium size. General color light to dark brown. Body usually stout in short-winged forms with all femora heavy. Chevron-like markings on femora always broken. Lower lobe of distal end of hind femur without conspicuous black marks. Hind tibia bluish. Cerci tear-shaped and pointed. Furcula absent or reduced to very minute points. Long winged forms resemble Melanoplus. Severe range-land pest west of the continental divide.



Phoetaliotes nebrascensis (Thomas) "Big Headed 'hopper" or "P. neb."

Very similar and often confused with M. lakinus. Size small to medium. General color grayish brown or reddish brown above, greenish yellow beneath. Hind tibia bluish or purple. Head large, swollen and distinctly raised above pronotum. Pronotum moderately tectiform, flared to receive head. Tegmina abbreviate, lanceolate, occasionally fully winged. Supra-anal plate triangular with sides slightly convex and apex bluntly pointed. Furcula minute, triangular and well separated. Cerci short and tapering from broad base to acute apices. Subgenital plate narrow and not elevated apically although the apex is slightly produced in a narrow projection. Common in western and midwestern grasslands.



Schistocerca americana (Drury) "Bird Grasshopper"

Size very large - two or more inches long. General color brown with contrasting markings of lighter stripes forming a conspicuous pattern. Disk of pronotum slightly convex and marked with a broad pale median stripe. Tegmina greatly exceeding abdomen with dark spots in median field. Caudal femora long and slender exceeding tip of abdomen. Cerci large and oblong. Subgenital plate curving acutely upward with a deep notch at apex. Strong flyer with undulating pattern. Generally rests in low trees, shrubs, tall weeds, etc. Primarily found in the corn belt states.

Schistocerca shoshone (Thomas) "Green Bird Locust"

Size large. Foliage green color with red hind tibia. Head and pronotum usually with a median yellow stripe. Tergites of abdomen without small black rows and dots found on most members of this genus. Usually associated with brush or shrubby trees in the mountain states.

Schistocerca vaga (Scudder) "Gray Bird Locust"

Size large - two or more inches long. Body mottled gray. Antennae buff. Tibiae dark with black tipped white spines. Usually forbes feeder. Found in southwest.

OEDIPODINAE - Band Wings

Pro-sternum without tubercle or spine. Fastigium sloping sharply downward. Antennae usually simple. Pronotum generally wrinkled or covered with small tubercles. Median carinae cut by two sulci and often raised to a distinct crest. Caudal margin of pronotum always produced to approximate a right angle. Tegmina and wings always fully developed. Wings of many species brightly colored. Their general color is usually a dull brown to gray. In flight they frequently stridulate making a crackling sound. They will be found in areas of grass associated with brush, light timber, and rocky hills.

Arphia pseudonietana (Thomas)

Size medium to large. General color blackish brown to black, sometimes mottled with grayish brown above, dark yellow or buff to dark brown beneath. Pronotum with median carinae feebly arched; occasionally whitish or yellowish dorsally; few scattered tubercles. Caudal femora dark brown with pale annulus near knees. Caudal tibiae almost black to a broad pale proximal annulus. Hind wing with disk from rich pink to reddish orange; band continuous along anal margin; spur two-thirds along costal region. Prefers open places, dry vegetation and areas of poor or gravelly soil.

Camnula pellucida (Scudder) "Clear-wing 'hopper"

Size small to medium. Form slender and compressed. General color light brown with darker markings. Pronotum with median and lateral carinae; lateral lobes with black spot. Tegmina with two light colored stripes dorsally along overlapped margins. Hind wings transparent. Femora yellowish brown with two to three darker bars. Caudal tibiae yellow. Very gregarious, especially during early nymphal stages and at egg deposition. Found only at higher elevations or northern latitudes. Prefers grassy meadows where it occasionally does considerable damage.

Chortophaga viridifasciata (De Geer)

Size medium. Color either largely green, wholly brown or mixture of both. Head with vertex considerably produced. Hind wing pellucid basally, fuscous apically. Outer face of femora green or brown. Tibiae brown or pale blue with whitish annulus. Adults appear early in spring. Prefers damp areas of grass and weeds.

*Conozoa wallula* (Scudder)

Medium size. Wings yellow with black band and spur. Pronotum with median carina distinct and cut twice. Lateral lobe of pronotum acutely angled at rear. Tegmina with two dark bands on costal margin. Hind tibiae reddish to yellow with pre-basal pale band. Occurs in grassland in northwest states.

*Cratypedes neglectus* (Thomas)

Size large and robust. General color very dark. Tegmina with indistinct bands; pale dorsal stripe. Hind wing with yellow disk and black border, spur extending midway to base, transparent apex. Pronotum with lateral lobes expanded below mid-line. Caudal tibiae bright red. Overwinters in some areas as a nymph. A grassland feeder found in western high plains and high elevations.

*Dissosteira carolina* (Linnaeus) "Carolina Grasshopper"

Size medium to large. Body strongly compressed. General color variable from dusty brown to reddish brown. Pronotum strongly arched and deeply cut by single sulcus. Tegmina long, exceeding tip of abdomen by one-third their length. Hind wing black with pale to yellow band. Widely distributed and easily found along roads, trails, and rangelands. Often seen hovering while in flight.

*Dissosteira longipennis* (Thomas) "High Plains Grasshopper"

Very similar to *D. carolina* except tegmina with distinct brown blotches tending toward bands. Formerly the scourge of the high plains.

*Dissosteira spurcata* (Saussure)

Pale winged grasshopper, yellowish or grayish to brown, more or less distinctly marked with brown. Disk of wing clear, cloudy submarginal band often faint.

*Hadrotettix trifasciatus* (Scudder)

Size large and robust. General color gray through reddish brown to dark brown. Antennae long and heavy. Pronotum finely rugous. Tegmina not exceeding tip of abdomen; marked with three broad transverse

bands. Hind wing with light yellow disk; submarginal band broad; spur either very short or absent. Caudal femora with inner face blue with light colored apical band. Caudal tibiae orange to red. Common species of grasslands of great plains.

Hippoiscus rugosus (Scudder)

Size large and robust. General color light to dark brown. Antennae yellow at base to reddish brown apically. Pronotum with broad low median carinae. Tegmina shorter than abdomen; straw colored with large dark brown markings; two light colored stripes along over-lapped margins. Hind wing disk yellow through orange to pink, black sub-marginal band, apex transparent. Caudal femora bright yellow on inner face with three transverse black bars. Tibia yellow. Overwinters as both egg or nymph. Range-land species of the great plains.

Metator pardalinus (Saussure)

Size small (males) to medium (females). General color dark brown above, bluish cast beneath. Head large. Pronotum with median carinae high with two incisions. Tegmina marked with an irregular band of dark blotches, two yellowish dorsal stripes converging posteriorly. Hind wings with disk yellow to red, dark sub-marginal band, spur long. Abdomen with plural membranes blue giving it the appearance of being banded. Caudal femora inner surface blue. Caudal tibiae blue. Western species in short range grasses.

Pardalophora haldemanii (Scudder)

Size large and robust. General color grayish brown. Antennae slender. Pronotum coarsely and conspicuously rugous, sharply angulate posteriorly, an oblique light band dorso laterally on either side. Tegmina exceeding abdomen with many contrasting maculations. Caudal femora inner and ventral surfaces normally buff through peach red - never blue. Caudal tibiae normally buff through pale red. Hind wing yellow through pink to light red with broad submarginal band. Found in midwest and plains states in dry or sandy areas.

Spharagemon bolli (Scudder)

Size large for genus, slender and somewhat compressed. General color grayish to rusty brown. Pronotum weakly crested. Tegmina weakly banded. Caudal femora trifasciate on inner surface. Caudal tibiae pink to deep orange with broad dark annulus following light annulus. Prefers barren spots in woodland areas.

Spharagemon collare (Scudder)

Similar to S. bolli except: smaller, pronotum acutely crested.

Spharagemon equale (Say)

Similar to S. bolli except: tegmina marked with fuscous bands, pronotum weakly crested and deeply cut by principle sulcus, inner face of femora with four bands.

Trachyrhachys kiowa (Thomas)

Size small. General color dark grayish brown, sometimes tinged with green. Pronotum median carinae moderately high and cut by two deep sulci, lateral lobes of pronotum sharply angulate. Tegmina with two distinct bands, the third wanting or obsolete. Hind wing tinged with yellow with no distinct band. Caudal femora with upper and lower carinae elevated; the upper strongly so and decreasing sharply midway. Caudal tibia blue with pale proximal annulus. Western grassland species. Very common and often quite destructive in ranges.

Trimerotropis pallidipennis (Burmeister)

Size large. Form slender. General color gray marked with brown. Pronotum not crested. Tegmina with two fairly distinct bands, the third wanting or obsolete. Hind wing disk yellow; submarginal band narrow and dark, spur long. Caudal femora with inner face yellow with two dark bands. Caudal tibiae yellow to buff. A southwestern species.

Xanthippus corallipes latifasciatus (Scudder) "Red Shanks"

Size large and robust. General brown with distinct markings. Pronotum strongly rugous. Tegmina marked with dark blotches. Disk of hind wings yellow or pinkish; black band and transparent apices. Caudal femora with inner face coral red. Caudal tibiae bright coral red. Found abundantly in northern great plains.

## GLOSSARY

angulate	forming an angle
'annulus (pl. annuli)	a circular, transversal band
anterior	toward the front or head
apex	point farthest from point of attachment
apically	toward the apex
bisinuate	having two curved incisions
carina (pl. cerci)	a ridge
caudal	nearest the rear
cercus (pl. cerci)	flap-like structure on each side of the male genitalia (occurs in female, but usually is of generalized shape)
costal	the leading or front portion of the wing
deplanate	flattened
distal	farthest from point of attachment
disk	of pronotum - the entire dorsal surface of femora - the outer surface of wing - semi-circular area within submarginal band
dorsal	pertaining to the upper back
fasciate	having broad bands of color
femur (pl. femora)	the thigh - the third part of leg from extremity
furcula (pl. furculae)	appendage located above and attached at base of the supra-anal plate
fuscous	dusky or smoky
glaucous	sea-green; pale bluish green
lanceolate	lanced shape
maculate	spotted or marked

mesothorax	the middle thoracic ring
ovipositor	a femal organ used in excavating for egg deposition
post	prefix meaning after
pronotum	saddle shaped structure covering the sides and back of prothorax
prothorax	the first thoracic ring
proximal	part of appendage nearest point of attachment
retrorse	directed backward
rugous	wrinkled
sinus	a natural cavity or hollow
spatulate	flattened, club shaped with rounded apices
spur	of <i>Cyrtacanthacridinae</i> - the spine between the front legs
	of wing - that portion of the band that extends toward the body (taenia)
	tibia - claws at the distal end of the tibia
sternite	a section or plate on the underside
stridulate	a creaking, rasping, or other noise made by rubbing two surfaces together
sub	prefix meaning nearly or under
subgenital plate	the last ventral segment of the abdomen
sulcate	grooved
sulcus (pl. sulci)	groove or notch
supra-anal plate	top abdominal section of the last segment
tarsus (pl. tarsi)	the foot
tectate	roof shaped

tegmina	forewing or wing cover
tergite	dorsal portion of segment
thorax	the second or middle section of the body
tibia (pl. tibiae)	the segment of the leg between the femur and the tarsus
trifasciate	with three bands
tubercl <e>s</e>	a small lump or button
ventral	pertaining to lower surface or underside
vertex	the top of the head

## BIOLOGICAL FACTORS

### DISEASES

Fungus diseases - A fungus, Empusa grylli, can cause heavy loss of grasshoppers. Infected grasshoppers assume a characteristic pose at the extreme top of weeds, alfalfa, or sweet clover plants. With heads upward, they embrace the plant with front and middle legs and extend the hind legs laterally.

Beauveria glabulifera - Infected grasshoppers characteristically die on the ground under cover of vegetative growth and are enveloped with a white, cottony fungus.

Bacterial disease - Coccobacillus acridiorum appears to be the most important bacterial disease of grasshoppers. Those killed by this disease are found lying on the ground with blackish, small abdomens, and more or less liquid body content.

### PARASITES & PREDATORS

Frequent examinations of grasshoppers should be made for parasites. Parasites may be external, as in the case of red mites, or internal, as with sarcophagid flies (flesh flies) and nematodes.

Sarcophagid maggots (Sarcophagidae), if present, can be easily found by pulling the grasshopper head from thorax.

The nematode larvae, Mermithidae, mature and mate in the ground. Females crawl up on hairy plants where they deposit eggs which, in turn, are ingested by feeding grasshoppers. Eggs hatch and emerge as small worms in 'hopper's stomach. Worms are long and very slender, giving appearance of a piece of thread.

Red mites, Eutrombidium locustarum (Walsh) frequently parasitize grasshopper nymphs and adults, attaching themselves in places the grasshopper cannot reach with its legs or mouth parts. They suck out body juices and retard activity, but rarely kill.

Robber flies (Asilidae) have been reported attacking grasshopper nymphs, but are of small economic importance.

Several species of large-size wasps paralyze grasshoppers--bury and lay eggs on them.

Spiders consistently catch and destroy large numbers of grasshoppers, especially the common orange garden spider, Miranda aurontia (Lucas).

Birds and small mammals are predacious upon grasshoppers. They consistently reduce the grasshopper population, but rarely hold it in check, except possibly in restricted, localized areas.

### GRASSHOPPER ADULT SURVEY INSTRUCTIONS

Soon after grasshoppers have dispersed from nymphal concentrations and have reached the adult stage, all infested areas should be surveyed. This survey should be timed to coincide with peak populations, enabling completion of the survey before appreciable decline in grasshopper numbers occurs. Optimum time for observation of adult populations in some areas may occur before formal adult surveys start. If so, the surveyor should count, record, and map the occurrence. These known infestations combined with the later infestation information should be classified and mapped according to the table below.

#### Evaluation of Adult Populations

The estimated number of adult grasshoppers can be arrived at either on a square-yard basis or through a series of square-foot samples, depending upon conditions. The latter involves a number of actual counts of grasshoppers as they leave a square foot, selected by the surveyor well ahead of his line of march. Eighteen counts should be made 15-20 paces apart through the range, field, or margin being sampled. At the completion of the count, the total number of grasshoppers from the 18 square feet should be computed. This total divided by 2 will convert this figure to the number of grasshoppers per square yard. It is advisable, whichever method is used, to occasionally lay off a square yard or square foot on the ground to keep the size of these units fixed in mind.

Rating Table  
Grasshopper Adult Infestations

No. of Adults Per Square Yard		Rating	Map Color
Field*	Margin**		
0-2	5-10	1	White
3-7	11-20	2	Green
8 or more	21 & above	3	Red

\*Field stop ratings are to be used for both rangeland and field crop stops.

\*\*For obvious reasons, there will be no margin rating for rangeland stops.

The time of day, temperature, winds, density and height of vegetation all affect grasshopper activity and should be considered in making counts of grasshoppers.

Where hatching has been irregular and where populations of mixed species exist, nymphs may be present with adult grasshoppers. In making the adult survey, if the nymphs are in the fourth or fifth instars, they should be counted as adults. If the occurrence of large numbers of first to third instars of nymphs of economic importance is encountered frequently in an area, it is advisable to delay the survey until a later date. If a delay is impractical and this situation involves only an occasional stop, reduce the count of first to third instar nymphs to one-third before the figure in terms of adults is recorded on the roadmap.

In large field areas where fields consist of 80 acres or more and in range areas where the vegetation is uniform, only one habitat need be examined at each stop.

In diversified crop areas where fields are usually less than 40 acres, two or more fields should be sampled. In range areas where several vegetative types exist, each of the habitats should be sampled. The population in each crop and habitat should be determined. These populations should be averaged to determine a population for the stop. This average population of all fields or habitats sampled is used to rate the stop.

In all cases, the observer should walk sufficiently far into each field or range area to insure that the count of grasshoppers represents an average value for the area examined. Likewise, on the margin, a sufficient length of the margin should be examined to insure an average count. Population counts on the margin should also represent an average value for the entire width, from the edge of the road to the edge of the field. Most margins will be 2 or more rods wide, and for all such margins the population count should be recorded as an average for the entire width and the length examined. However, for narrow margins of less than 2 rods, the population count should be reduced proportionately. For example, the population count on a one-rod margin would be reduced one-half. When there is no distinct vegetative difference between the field and the margin and there is no concentration of 'hoppers along the margin, the field count should be recorded for the stop. No separate margin count need be made. This would apply to some ungraded roads or to roads through crops. Do not use margin counts in evaluating range stops.

After the number of grasshoppers per square yard has been determined for any stop, a rating for that stop is recorded on county outline roadmap from the adult rating table found on the preceding page. When marginal and field ratings differ, the higher rating should be assigned to the stop. The field counts are not to be combined with the marginal counts and averaged to obtain stop ratings.

The stops in the various crops and range should be well distributed and in approximate proportion to their relative county acreage.

The adult survey should be started in each state at the earliest possible time, determined by the maturity and behavior of the grasshoppers, and completed, where possible, within a period of two weeks. Actually, the best survey is that which is the culmination of the whole season's observation of grasshopper developments by the surveyor who had the opportunity to observe them in given areas. From 25 to 50 stops should be made in each county, depending on the nature of the infestation, the supervisor's knowledge of the infestation, and the size of the county. Fewer survey stops are required in an area which is lightly and evenly infested than in an area which is heavily and irregularly infested. In small counties where the supervisor is familiar with the infestation, 25 stops will usually be adequate. Areas in which infestations are of doubtful degrees of intensity and areas which border known, heavy infestations should be given more attention, and as many as 40 stops may be needed. Only in large counties or ones with extremely irregular infestations should it be necessary to make as many as 50 stops.

At the discretion of the supervisor, some counties or portions of counties may be omitted from the survey schedule. In cases where surveyor is not familiar with grasshopper species, the supervisor may request that a minimum number of collections be made in the more heavily infested areas. Identification of these collections will be made later to determine species complex and information recorded on PPC 3-68 for the county concerned.

#### Forms, Maps, and their Routing

Using a roadmap (see Exhibit 3) which shows county outlines, and preferably one with a white background and without too much color, the surveyor should mark and rate each stop in a county as it is made. The mark can be a dot placed as near actual location as possible on the map, with the rating for the stop placed beside the dot. A suggestion is to place the dot on the map the color of the rating. The rating, of course, will be in accordance with the rating table shown on a previous page. In some instances, the State Supervisor may wish to have the actual count per square yard recorded on the map at the point of each stop, rather than the numerical rating.

A copy of Form PPC 3-68, "Narrative Summary", is attached (Exhibit 4). The information requested on this form is extremely important. The sample form illustrates the kind of information desired. Answers should give a word picture of grasshopper conditions and call attention to the significant and outstanding features of the survey findings. Statements should be brief and revealing and give only pertinent information.

Each surveyor is also required to prepare a colored map of the area in which he makes an adult survey. This should be done in consultation with his supervisor, using a roadmap which shows county outlines and based upon ratings of the adult survey stops. The supervisor's previous observations and knowledge of the area, species involved, grass cover, and other influencing factors should be considered. The map should be colored, using colors as shown in the rating table.

The adult survey form PPC 3-68, rating (stop) map, and the colored map are to be prepared in \_\_\_\_\_ and sent immediately to \_\_\_\_\_. After consolidating data, the handwritten original of each is to be sent to the Regional PP&QP office. Copies of each of the above may be distributed to state cooperators, state PP offices, or as otherwise instructed. It is preferred that the necessary copies of the form be prepared in the field at the time of making the survey, rather than be typed in the office.

#### GRASSHOPPER ADULT SURVEY STATE SUMMARY

Immediately at the conclusion of the survey, the State Supervisor in Charge will prepare for each state under his supervision a Summary Report covering the following:

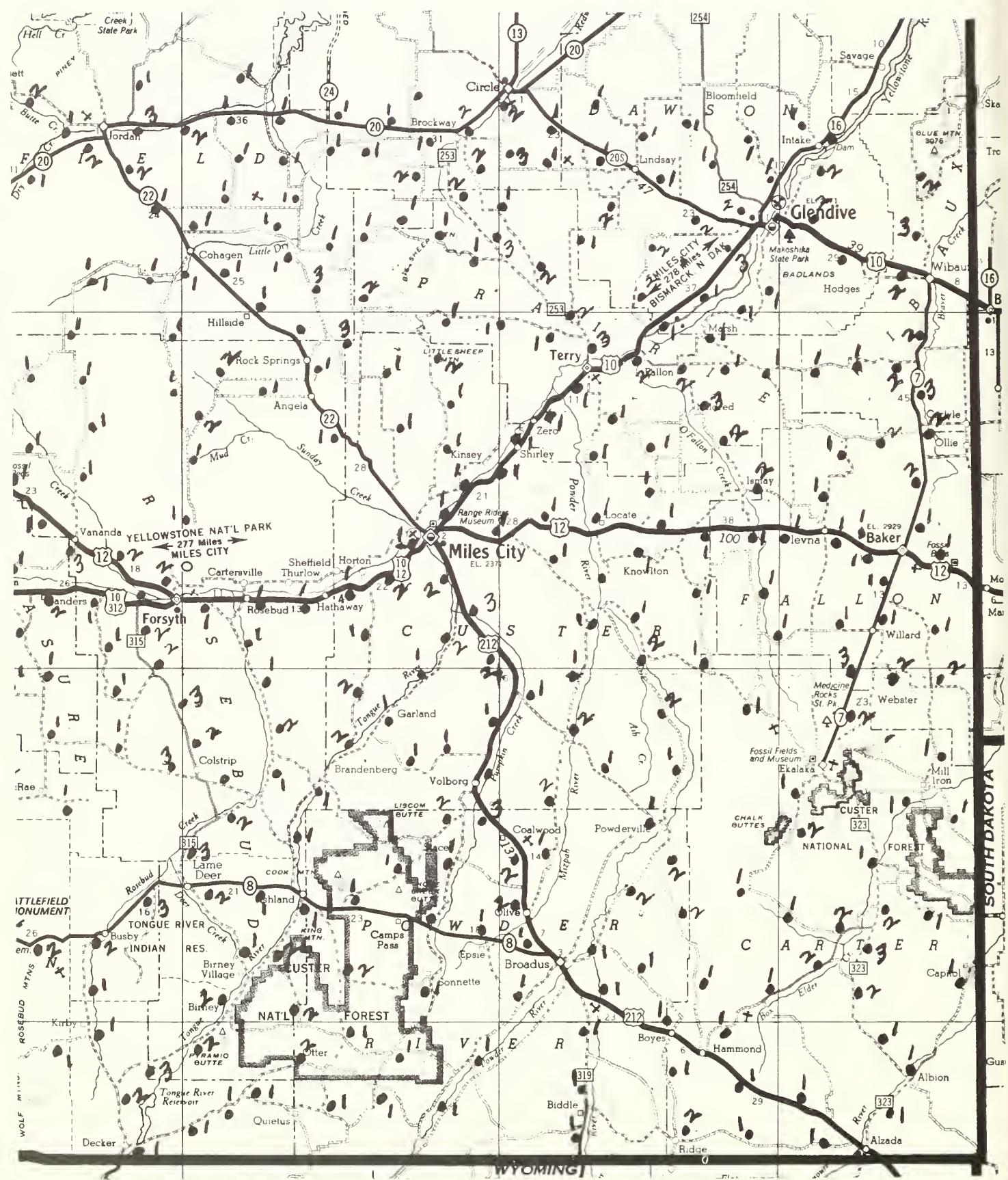
Estimated acreage infested - 3 rating only

Cropland \_\_\_\_\_

Rangeland--Acreage must be shown by agency,  
by county, naming the particular  
forest, reservation, park, or  
refuge affected.

Private	_____	BLM	_____
State	_____	Indian Service	_____
Forest Service	_____	Park Service	_____
Fish and Wildlife	_____	Other (Specify)	_____

## EXHIBIT 3



## EXHIBIT 4

## GRASSHOPPER ADULT SURVEY - COUNTY SUMMARY

NOTE: Write legibly. Make brief, pertinent, and inclusive statements.

2. SURVEYOR

L. B. Factual

3. STATE

Montana

1. DATE

July 10, 1967

4. COUNTY

Big Horn

## 5. PORTION OF COUNTY INFESTED

Range areas south of Hardin and west of Hwy. #87, and area along Wyo. State line from Decker east to Quirtus.

## 6. LIST THREE PRINCIPAL GRASSHOPPER SPECIES WHERE ECONOMIC POPULATIONS OCCURRED

M. sanguinipes  
Aul. ellotti  
Cam. pellucida

## 7. GENERAL CONDITION OF RANGE (Moisture, grass cover, etc.)

Very dry with exception of extreme SE portion of county where late rains occurred. Winter cattle range has good stand of grass throughout county.

## 8. ESTIMATED ACREAGE INFESTED (3 Rating Only)

TYPE ACREAGE	Acres	TYPE ACREAGE	Acres
Crop Land	25,000	Range Land (Continued) Bureau of Land Management	15,000
Range Land		Indian Service	35,000
Private and State	206,000	National Park Service	---
Forest Service	120,000	OTHER (Specify)	
Fish and Wildlife Service	5,000		

## 9. IN YOUR OPINION, WAS SURVEY EARLY OR LATE?

Too late to evaluate early maturing species, yet at high elevations 15-20% were nymphs still in 3<sup>rd</sup> and 4<sup>th</sup> instar.

## 10. NUMBER OF STOPS MADE

42

REMARKS (Observations of flight, migration, concentration for egg deposition, parasites, predators, crop or rangeland damage observed, or any other facts pertinent to this survey)

No flights observed or reported.

Hoppers concentrating along roadsides, green ravines, and drainage areas. Heavy population of blister beetles along the Big Horn River from Hardin south to Fort Smith.

Range grasses had suffered 10-15 % damage in the Hardin and Decker areas. Some individual rancher controls applied along Big Horn River near Hardin to save grass for roughage and winter grazing.

### PREDICTING THE HATCH

To determine when hatching will begin and how long it may continue is of primary importance. The factors to be considered are soil temperature, stage of embryonic development, and the number of developmental units necessary for the completion of incubation. Laboratory experiments and field observations have indicated that the minimum effective temperature for egg development is approximately 60° F. Therefore, a soil temperature of 1 degree above 60° F., acting through one day's time, is considered as one developmental unit.

It has been found that the number of developmental units necessary for completion of incubation and hatching in the spring ranges from approximately 100 to 400. It has also been observed that eggs gathered in the field can usually be classified into four stages of development. In the first stage the contents of the eggs are a clear fluid, in the second they become coagulated, in the third, eye spots develop, and in the fourth there is complete segmentation of the body parts. The number of developmental units necessary for complete development from each stage is roughly as follows: Clear fluid 400, coagulated 300, eye spot 200, segmented 100. These numbers consider the beginning of each stage to hatching and are used in gross method of estimating time of emergence.

The difference between the average soil temperature and 60° F. is divided into the number of developmental units necessary to complete development from a particular stage. The expected length of time before hatching is determined as follows: If eggs of a given species occur in all stages of development and the average soil temperature is 80° F., then hatching will be continuous for at least 20 days. Unseasonably low temperatures disrupt these calculations, but the method does give some idea as to the time of hatching.

When the soil temperatures are unknown, one can estimate that eggs still in the first stage will hatch within 20 to 25 days after soil temperatures above 60° F. occur daily, in the second stage 15 to 20 days, in the third 10 to 15 days, and in the fourth 5 to 10 days unless already advanced to the point of hatching (see following table). Generally the observer will not be able to spend the time necessary to make soil temperature readings. It is advisable, therefore, for him to become familiar with the four stages of egg development and how to estimate their approximate hatching time.

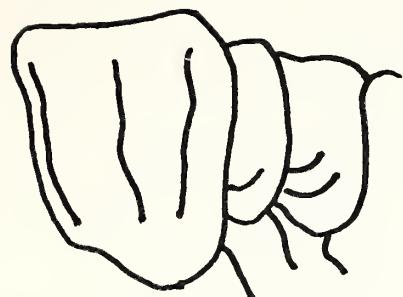
Estimated Days to Hatching for the Four Stages  
of Egg Development at Different Soil Temperatures

Egg Stage	Developmental Unit	Days to hatching at average soil temperatures of			
		85°F.	80°F.	75°F.	70°F.
Clear	400	Days 16	Days 20	Days 27	Days 40
Coagulated	300	12	15	20	30
Eye Spots	200	8	10	13	20
Segmentation	100	4	5	7	10

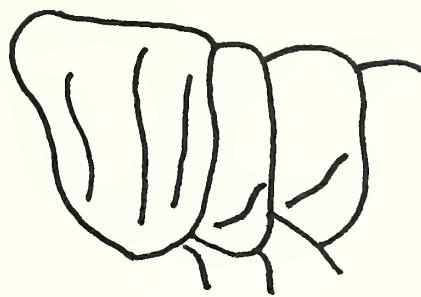
## KEY TO STAGE OF GRASSHOPPER DEVELOPMENT

1. a. Tegmina and wings in the form of pads. . . . . 2  
b. Tegmina and wings fully developed. . . . . 7
2. a. Tegmina and wing pads pointing down. . . . . 3  
b. Tegmina and wing pads pointing up. . . . . 6
3. a. Tegmina and wing pads with indistinct  
venation . . . . . 4  
b. Tegmina and wing pads with distinct  
venation . . . . . 5
4. a. Wing pads rounded, with no visible  
bulge at apex. . . . . 1st instar  
b. Wing pads rounded, with visible  
bulge at apex. . . . . 2nd instar
5. a. Wing pads more sharply triangular  
and pointed ventrad more vertically. . . . . 3rd instar  
b. Wing pads more elongated, rounded  
and pointed ventrad more obliquely . . . . . Extra instar
6. a. Wing pads short, not extending beyond  
first abdominal segment, more truncate . . . . 4th instar  
b. Wing pads elongate, extending beyond  
the second but hardly beyond the  
third abdominal segment, more  
pointed at the apex. . . . . 5th instar
7. a. Tegmina and wings fully developed,  
the tegmina overlying the folded  
wings. . . . . Adult

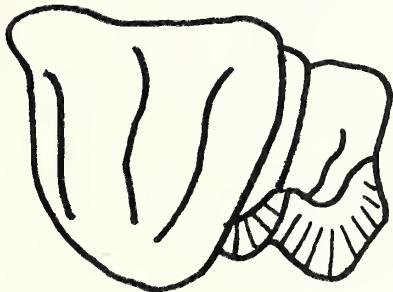
## DEVELOPMENTAL INSTARS OF GRASSHOPPERS



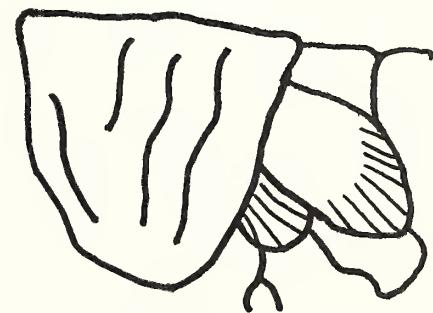
1st Instar



2nd Instar



3rd Instar



4th Instar (Extra)



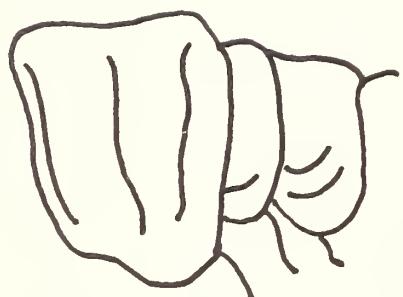
5th Instar



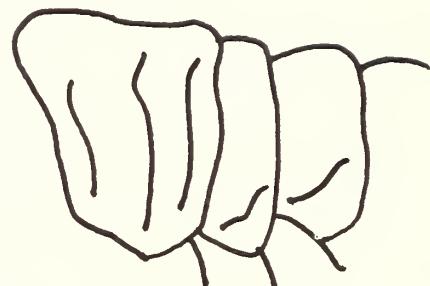
6th Instar

## DEVELOPMENTAL INSTARS OF GRASSHOPPERS

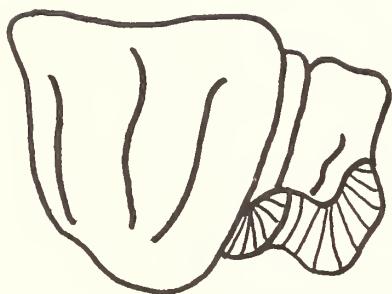
## FIVE INSTAR NYMPH



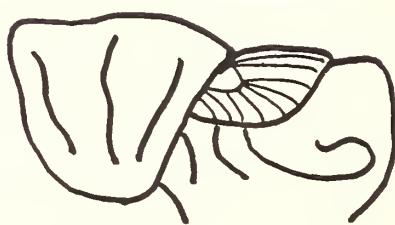
1st Instar



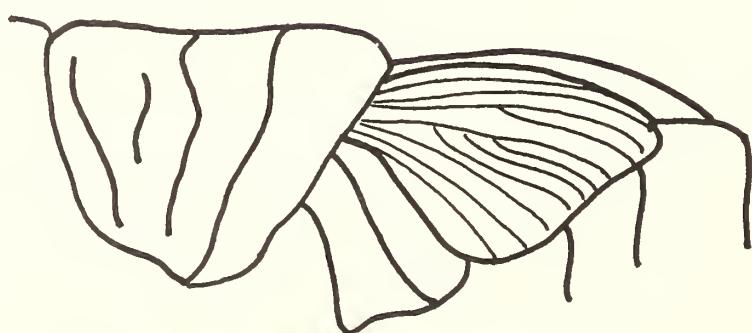
2nd Instar



3rd Instar



4th Instar



5th Instar

### GRASSHOPPER NYMPHAL SURVEY INSTRUCTIONS

Surveys for grasshopper nymphs are started as early as possible in the spring of the year, the time varying with the weather conditions, areas being surveyed, and species involved. This survey serves to verify the adult survey and winter survival of eggs, numbers of which are often reduced considerably by depredation of predators and parasites. It also serves to establish definite areas and the need for control thereon in both range-lands and croplands.

For the purpose of evaluating nymphal populations, the following rating table should be used.

Rating Table  
Grasshopper Nymphal Populations

No. of Nymphs per sq. yard	Rating	Color
0 - 2	1	White
3 - 7	2	Green
8 and above	3	Red

Nymphal populations of 8 or more per square yard, if the nymphs are in the fourth or fifth instars, will be considered economic and the acreage so infested will be recorded on the appropriate work-measurement form.

Nymphal survey stops should be made at a minimum of 5-mile intervals throughout a county. Some areas may be omitted such as certain forested, slab rock, high elevation, or areas historically supporting noneconomic grasshopper populations.

All nymphal survey stops are to be recorded on a white background roadmap, using the numerical rating (1, 2, or 3) based upon population counts as shown in the above table. In some instances the State Supervisor may wish to have the actual nymph count per square yard recorded on the map at the point of each stop, rather than the numerical rating.

Each map should clearly show the surveyor's name and period (date) survey is made. A new map will be required each time a survey is made in each county.

NYMPHAL DESCRIPTIONS  
(Five Commonly Found Species)

Melanoplus differentialis

The nymphs are dark and heavily mottled, some are nearly all black. There is a yellowish lateral thoracic stripe, wide at the anterior end, which extends from the front to the hind margin of the pronotum. The outer face of the femur has a series of chevrons. The upper half to three-fourths is black or brown, broken by alternating light areas. The lower part of the chevrons is usually clear yellowish or yellowish-white.

Melanoplus bivittatus

The nymphs are usually lighter and less mottled than the differentialis. The yellowish background color is usually found to be bright and often nymphs beyond second or third instar are green marked with black. There is a yellowish lateral thoracic stripe, wide at the anterior end, which extends from the front to the hind margin of the pronotum. The outer face of the femur is designed with a series of chevrons. The upper half to three-fourths of the chevron is solid black to dark brown. The outer face of the upper portion of the femur is clear yellowish to green. The lower part of the chevrons are yellowish or yellowish-white to green.

Melanoplus sanguinipes

The nymphs in the earlier stages are mottled blackish, but become less mottled, paler, and the body markings are more definite in the later stages. A light stripe begins below the eye and curves upward and back along the sides of the thorax; the hind femora are banded on top and the dark femoral stripe is commonly broken by a light band; males have a notch at the extreme of the abdomen.

Melanoplus femur-rubrum

The nymphs have strongly contrasting black and whitish green or yellowish markings. The early instar nymphs have a whitish crescent along the sides of the pronotum that continues part way across the cheeks. The black band of the femur, which is not broken, covers the upper third of the lower chevrons. The entire outer face of the femur in the first instar nymphs is commonly black or smokey, and two dusky spots usually occur on the inside of the upper flange.

Camnula pellucida

The nymphs are mostly black with a distinct white collar around the thorax during the first and second instars, but gradually change to a mottled gray or brown color in the later instars.

CAMNULA PELLUCIDA



First Instar



Second Instar



Third Instar



Fourth Instar



Fifth Instar

Female

Male

A d u l t

MELANOPLUS SANGUINIPES



First Instar



Second Instar



Third Instar



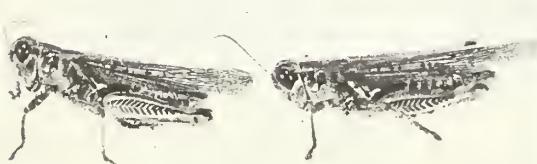
Fourth Instar



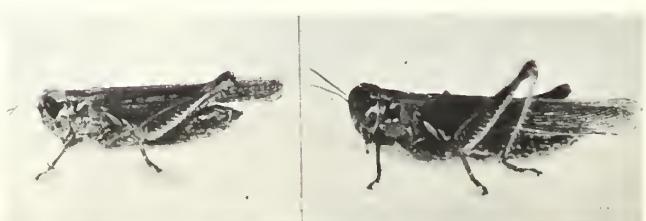
Fifth Instar



Extra Instar



Males



Females

A d u l t

MELANOPLUS BIVITTATUS



First Instar



Second Instar



Third Instar



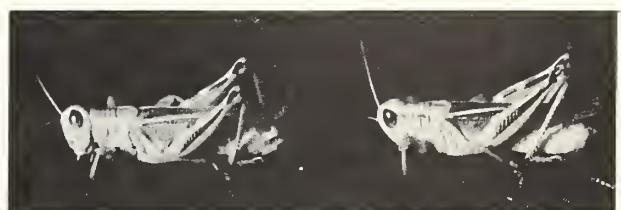
Fourth Instar



Second, Third, Extra, Fourth  
Instars



Fifth Instar



Female

Male

A d u l t

MELANOPLUS DIFFERENTIALIS



First Instar



Second Instar



Third Instar



Fourth Instar



Fifth Instar



Sixth Instar



Female

Male

A d u l t

# GRASSHOPPER ADULT SURVEY

## WORKSHOP AREAS

with principal grasshopper species





MELANOPLUS FEMURRUBRUM



First Instar



Second Instar



Third Instar



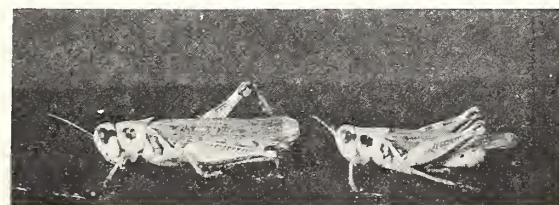
Fourth Instar



Fifth Instar



Adult

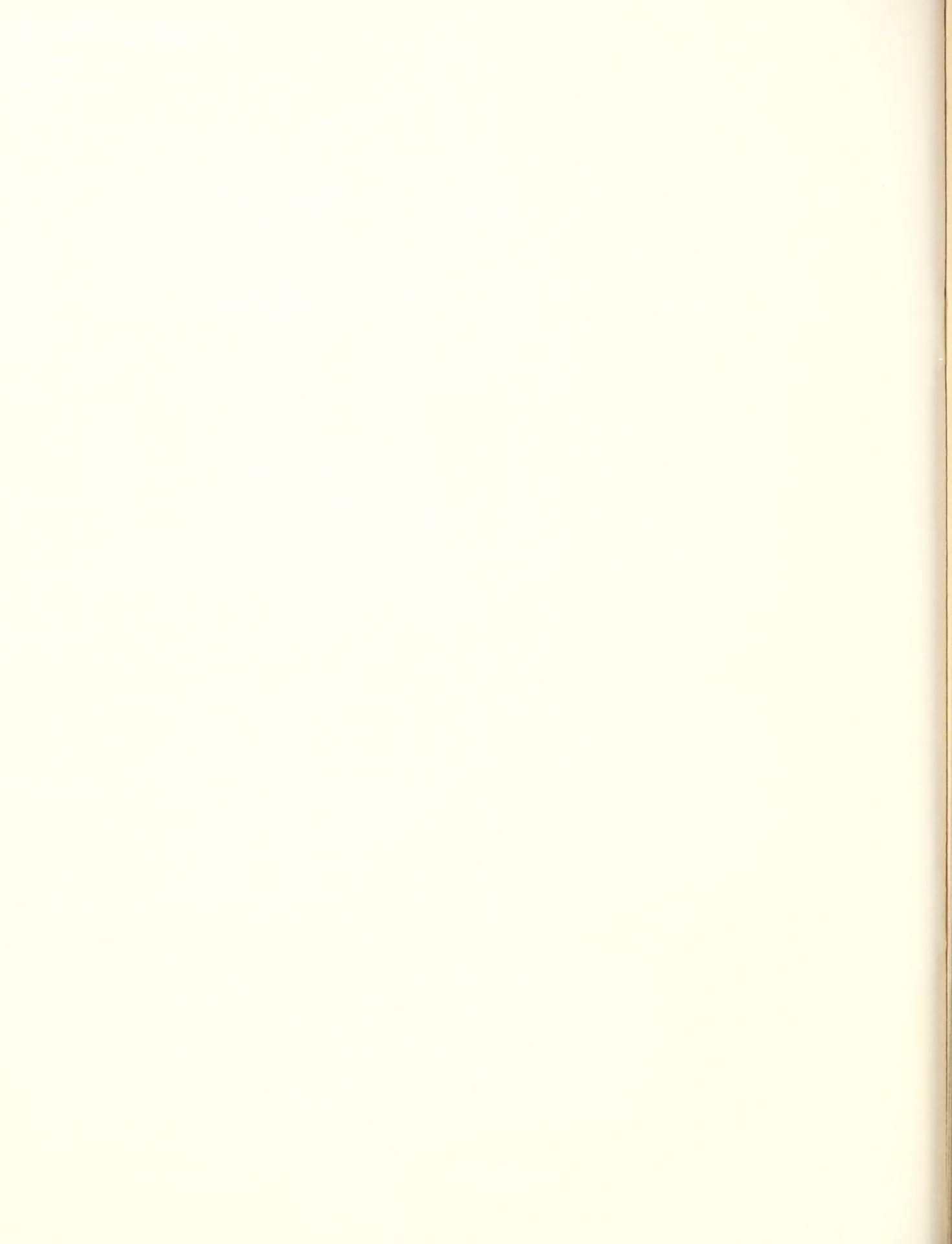


Female

Male

GPO 791-333

A d u l t







1022737501

Happiness

IS THE EARLY DETECTION OF A NEW PLANT PEST

Be Alert

INSECT DETECTION is for YOUR PROTECTION